NOTES ON THE ARREST OF HEPATIC HEMORRHAGE DUE TO TRAUMA.

BY J. HOGARTH PRINGLE, F.R.C.S.,

OF GLASGOW,

Lecturer on Surgery in Queen Margaret College, Surgeon to the Glasgow Royal Infirmary.

RUPTURE of the liver is fortunately an accident not often met with, but one which, when it is seen, may be associated with a condition of the patient as serious as any one can meet with in surgical practice. While small lacerations of the liver substance may be, and, no doubt are, recovered from without surgical interference; if the laceration be extensive and vessels of any magnitude are torn, hemorrhage will, owing to the structural arrangement of the liver, go on continuously, and by the time such a patient comes under the care of a surgeon the general state is almost invariably bound to be extremely grave, from the hemorrhage alone or from hemorrhage and shock combined, and this is perhaps specially the case in that class of injury due to contusing violence in which there is often gross injury inflicted on parts other than the liver and when shock is liable to be more severe than in localized injuries caused by sharp instruments.

The statistics collected by Terrier and Auvray show that wounds of the liver from contusing violence are much more fatal than localized cutting injuries for out of 44 patients operated upon for wounds of the liver caused by sharp instruments there were 7 deaths, whereas out of 23 patients operated on for wounds due to contusing violence there were 9 deaths.

During the last eleven years there have been eight patients admitted to my service at the Glasgow Royal Infirmary, who had sustained a rupture of the liver. Three of these patients suffering from the effects of gross traumatism died almost

immediately after admission to the hospital. Post-mortem examinations were made in these three cases, and in one of them it was found the liver had been torn completely into two halves along the longitudinal fissure; in another there was, in addition to an extensive laceration of the liver, a widespread fracturing of the base of the skull, with laceration of the brain and a fracture of the right femur. In the third, there was a dislocation of the knee along with fractures of the left fibula, right humerus and several of the right ribs, with a wound of the right lung as well as the liver injury. The condition of each of these patients was hopeless from the beginning. The other five patients survived their injury, so far as to enable an extended examination to be made, and on four occasions it was determined to open the abdomen upon the assumption that the patient had a rupture of the liver, in the hope that it might be possible to arrest the bleeding and perhaps save the patient, but the results were anything but gratifying, for all four patients died and two of them before their operation was completed. The remaining patient steadily refused operation and died on the third day after his injury.

In the case of the first patient, upon whom I operated, the abdominal cavity was not only found to contain a very large amount of blood, but as soon as the peritoneum was opened blood welled up in large quantities from an extensive laceration of the right lobe of the liver, and before anything could be done to arrest it the patient had died, not from the blood lost prior to the operation but from the profuse and uncontrolled hemorrhage that took place from the torn surfaces of the liver after the peritoneum was opened and the tension inside the abdomen released. Later it occurred to me that if the portal vein had been compressed in the anterior boundary of the foramen of Winslow the hemorrhage might have been so far temporarily arrested as to permit a thorough treatment of the torn vessels.

My second operation case came shortly after the first and after opening the abdomen an assistant held the portal vein and the hepatic artery between a finger and thumb and

completely arrested all bleeding, and we got on a little further in consequence of being able to wipe out blood and blood clot and to examine the rupture; several silk ligatures were passed and drawn up and some packing applied round the seat of the wound, but the patient died in spite of it, very soon after the operation was completed.

I had, in the interval between the occurrence of these two cases convinced myself, after observations carried out in the post-mortem room, that a completely satisfactory and tolerably easy method of arresting hemorrhage was probably to be obtained by passing ligatures through the liver substance at a sufficient distance from the margins of the wound to make certain they would not slip, and by pulling these up as tight as possible, allowing them to cut completely into the liver tissue; the coats of the vessels in the liver are sufficiently resistant to permit this to be done without giving way themselves. After this, if one obstructs the inferior vena cava and then forces fluid through the portal vein, it will be found that practically no escape will take place from a cut surface in the liver, even though the pressure of the fluid be very much greater than that of the portal blood stream in life—if any does come away, it is the merest ooze, and in actual practice any oozing of blood of this nature and degree could always, I believe, be controlled by packing.

This is the method originally described by Kusnetzoff and Pensky which I only learned after reading the very admirable paper of Anschutz, on Resection of the Liver. Kusnetzoff devised some special needles for passing the sutures—blunt-pointed and short, with varying curves. I used a handled needle of soft steel which could be variously curved as required and an improved model was made for me by Messrs. Baird Bros., Glasgow, which has proved quite efficient in these cases.

As far as my experience goes it is quite as easy to work with this suture as it is to employ the method of compressing the margins of the liver wound with such things as strips of whalebone as suggested by Cecherelli and Bianchi—or with

the articulated support of Segale—or the strips of magnesium metal more recently suggested by Payr and Martina; for each of these contrivances requires the use of sutures in the liver to hold it in position, and while magnesium may, as is claimed for it, be absorbed, it is quite probable that the whalebone or ivory strips, even though decalcified, might ultimately have to be removed. I do not believe these forms of apparatus will have any permanent place in the surgery of the liver but that they will disappear just as the bobbins, etc., have disappeared or are disappearing in the surgery of the gastro-intestinal canal.

When I began to look into the subject of the treatment of injuries to the liver and the arrest of hepatic hemorrhage it came as rather a surprise to find it stated in Langenbuch's volume, in the "Deutsche Chirurgie," on the Surgery of the Liver, that Ponfick and others had had such disastrous results from obstructing the hepatic and portal vessels in their experimental animals. I have not seen the original papers, but Langenbuch states that death of the animal occurred almost "at once from collapse" in some instances or "within a few hours" in others apparently owing to stagnation of blood in the portal area. I have some difficulty in understanding why an animal should necessarily die under such circumstances as rapidly as is stated to have been the case in these experiments, though, if the interference with the portal vein had been so long continued as to affect the vitality of the coats of the bowel it would lead to gangrene and peritonitis, but in that case death would not be immediate. At any rate, the method had afforded me such decided advantages at the time in the only case in which I had till then employed it, although the patient did not survive, and he certainly did not die because his portal vein had been obstructed, that it seemed it might be worth while to endeavor to determine the effect by experiment again. This I was enabled to do several years ago in the Pathological Institute in Vienna and I desire now to express my thanks to the Director, Hofrath Professor Weichselbaum, for the privileges so kindly afforded me there.

In my experiments I employed rabbits as Ponfick had previously done. The animals were anæsthetized with chloroform, the abdomen opened and the portal vessels clamped with a narrow pressure forceps, the blades of which were covered with rubber tubing. The first animal, a large buck rabbit, was kept in full anæsthesia for one hour after the clamp was applied to the vessels and during this time the surface of one of the lobes of the liver was freely cut into at several places but no bleeding followed; at the end of one hour this lobe was cut off and *then* the ligatures were passed through the stump and tied and after that the clamp was removed, but no blood escaped from the cut surface during the time that elapsed between the amputation of the lobe and the passing and tying of the ligatures; hemorrhage had been controlled as perfectly as could be desired. As far as the intestines were concerned the only change that had occurred by the end of the hour was that in color they were possibly a little darker than they had been when the abdomen was first opened, but even this was comparatively slight.

Three other animals were treated in the same way, but the clamp was only kept on the portal vessels long enough to permit the amputation of one of the liver lobes which was always done *before* passing the ligatures through the stump. Hemorrhage was completely controlled in all of them and no obvious change occurred in the appearance of the intestines. Moreover, all four animals recovered from the operation, fed well and developed no abnormal symptom, and, as the time at my disposal was short, were killed on the third or fourth day after the operations, but beyond recent adhesions round the cut and ligatured stump of the liver nothing abnormal was found on post-mortem examination in any one of them. It was not considered necessary, therefore, to continue the experiments over a greater number of animals, for their object seemed to have been attained. The animals survived the temporary obstruction of their portal circulation and did not appear to have been in any way injured by it.

Since these experiments were made two patients with rup-

ture of the liver have been operated upon by me, and in each case the hepatic and portal vessels were grasped between fingers and thumb as soon as the abdomen was opened, while blood clot, etc., was cleared out of the abdominal cavity and the necessary manipulations were being carried out on the liver. In both cases the method acted admirably, perfect control of the bleeding areas of the liver was obtained and a clear field for operating. Of these two patients the first to be operated upon died before the operation was completed. To the second of them I shall refer immediately.

A suggestion was made by Ponfick and it is spoken of with favor by Langenbuch, regarding the possibility of avoiding the dangerous congestion of the intestines which followed on obstruction to the portal circulation, and it is this, that the superior and inferior mesenteric arteries should be tied (temporarily) in the first place and then the portal vein obstructed; but it appears to me as the result of my experience with the experimental animals as well as in the case of three patients that this is not necessary. The time that would be required to tie the mesenteric arteries must be taken into account, for in the case of such patients with a degree of shock present that is always great and often extreme and moreover who are suffering from great loss of blood, time in the operation is a consideration of the first importance.

The proposal of these writers with regard to the freeing of the liver from its attachments to the diaphragm and posterior abdominal wall is, however, one of great value and would appear to offer considerable possibilities to a surgeon. For in these cases, after the further occurrence of hemorrhage has been prevented by holding the main vessels, and the field of operation has been cleared of blood, the difficulty of obtaining access to a wound situated far back upon the upper or lower surface and particularly the upper surface of the large right lobe of the liver is very great, and it will occasionally prove to be impossible unless more open access can be obtained. This, however, can be obtained in one of two ways, either (1) by dividing the coronary and right lateral ligaments

of the liver and thereby freeing it so as to allow the liver to be dislocated and delivered up to the abdominal wound as was originally suggested by Langenbuch; or, as I think (2), by freeing a portion of the lower thoracic wall by dividing the ribs and holding up this flap of ribs and diaphragm. I do not know whether either method has ever been employed in actual practice; the latter is possibly the more severe of the two, but it might be quicker to carry it out and it might, in consequence, save time.

The difficulty in such a case is to some extent illustrated by that of the last patient upon whom I operated. This man had symptoms pointing to rupture both of the liver and of the right kidney. I opened the abdomen first and could easily feel the liver wound situated on the right lobe, just in front of the upper layer of the coronary ligament; as far as the introduction of ligatures was concerned it was entirely inaccessible and I considered the question of making a thoracic flap or of dividing the ligaments to get access to it, but decided for the latter as it was necessary to explore the kidney from the loin and the possibility of urine escaping from the wound had to be kept in mind. In trying to carry out this division of the ligaments it proved an extremely difficult matter to get at them; in spite of the large perirenal hæmatoma which tended to project the liver forwards, for with the longest (8 inches) scissors available I could only reach and divide the lateral ligament. The convexity of the upper surface of the liver itself appeared to the chief obstacle to getting at the coronary ligament, but having got the lateral ligament divided it was found possible, by traction and pressure, etc., to tear the upper layer of the coronary ligament; although this succeeded to some extent it quickly became apparent that the rupture in the the liver tissue was being considerably enlarged by the manœuvre and it became necesszary in consequence of this to desist from further attempts in this direction. I had to finish by packing the suprahepatic space which, as it turned out, acted very well, for very little hemorrhage took place after this: the right kidney, was then exposed from behind and a large extravasation of blood there evacuated and the perinephritic space was packed also, for although the kidney was extensively ruptured it was thought the patient's chance of life would be diminished by

a nephrectomy at that time. He carried on well for two days and then developed signs of consolidation of the right lung and died on the fourth day after his accident and operation. At the post-mortem examination it was found that practically no further bleeding had occurred from the extensive rupture of the liver and none from the kidney and there was no peritonitis, but the right lung was in an early stage of gangrene, due, doubtless to embolism. It has been shown in the experimental work that embolism of the pulmonary vessels consequent upon thrombosis of the liver vessels is as common as it is fatal.

A question of some importance, in these cases, arises as to the time when operation should be carried out. One of my patients lived for three days after his injury, and although it was believed he had a rupture of the liver and operation was repeatedly urged upon him, he persistently refused to submit to it. He died with symptoms pointing to intestinal obstruction, viz., constipation and fecal vomiting, and at the post-mortem examination it was found that the abdominal cavity contained a very large amount of blood and there was a rupture of the liver far back against the coronary ligament which would certainly have been difficult of access for the purpose of applying ligatures to the torn liver vessels. But the liver wound was full of ante-mortem clot; the tendency to hemorrhage had been spontaneously arrested, and if the abdominal cavity had been emptied of blood and the region of the liver injury merely packed, the patient might have got through.

The mere act of opening the abdomen, in some, at any rate, of these cases is, I feel certain, associated with an increase of the amount of blood that is lost to the patient. The blood pressure in the portal vein is not great and as the result of the local injury and the extravasation of blood there is produced reflexly a state of firm contraction of the abdominal muscles. The abdominal wall in these cases becomes absolutely rigid and board-like, the tension in the abdominal cavity thereby brought about must prevent at least a *rapid* escape of blood and may lead to its arrest altogether. No patient could survive the sort of hemorrhage that occurred on

opening the abdomen of my first patient from the liver itself—not the mere escape of the blood already extravasated into the peritoneal cavity—for more than a few minutes, in fact, this patient died immediately as the result of this hemorrhage. It would have been impossible to have got such a patient transported to hospital alive, had it not been that the hemorrhage had been delayed in the manner suggested.

It is very probable that slight ruptures will occasionally heal without surgical interference in consequence of this increased tension of the abdominal wall leading to the arrest of hemorrhage, but in the cases of severe injury to the liver this will not happen; many patients if left without surgical aid, will die from hemorrhage or shock in the first place, or if they get over these dangers will succumb later from intestinal obstruction and peritonitis, when the extravasated blood becomes infected from the bowel, of which it has every chance, if such a patient hold on long enough. So that if these severe cases are to be got through at all, I feel that operation must be an immediate one for the majority, and that some of these patients can be saved is well seen from Terrier and Auvray's figures.

It is a most unhappy calamity that a patient, whose life one is endeavoring to save, should die before an operation is completed, but it is a risk that has occasionally to be faced and in these cases of injury to the liver, one is most likely to avoid it, I believe, by rapidity of operating, and this will be favored by the immediate arrest of the active hemorrhage that is going on, by seizing the portal vessels as soon as the abdominal cavity is opened; for by so doing one can obtain a clear field and therefore time is gained for the treatment of the wound of the liver itself.

The permanent arrest of hepatic hemorrhage is, in my opinion, best effected by ligation of the liver tissue in mass in every case where that is possible, but in some cases it may not be practicable and then we will have to rely solely upon packing.